
**Natural gas — Upstream area —
Determination of drag reduction in
laboratory for slick water**

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 193, *Natural gas*, SC 3, *Upstream area*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Shale gas needs large-scale volume fracturing to achieve commercial exploitation, slick water is an important part of volume fracturing technology, and its drag reduction directly affects shale gas fracturing operation. If the drag reduction of slick water is too low, it causes the high fracturing operation pump pressure, greatly increase the cost, and even cause the failure of the fracturing operation. This document aims at evaluating the drag reduction performance of slick water.

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Natural gas — Upstream area — Determination of drag reduction in laboratory for slick water

1 Scope

This document specifies a method for the determination of drag reduction of slick water, which is mainly used to evaluate the drag reduction performance of slick water.

This document uses the pipeline method to evaluate the drag reduction, which is currently recognized as the best method to evaluate the drag reduction performance.

This document describes the device, experimental conditions and operating steps in detail. The drag reduction value obtained by evaluation according to this document can effectively represent the on-site drag reduction performance.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

differential pressure

pressure difference between two points in the system

3.2

drag reduction

pipe flow friction of a given fluid relative to the pipe flow friction of distilled or de-ionized water

3.3

slick water

water-based fracturing fluid, composed of drag-reducing agent, other additives and water

3.4

volume fracturing technology

process of injecting water and sand at a high enough pressure into a well to break the rock and expanse natural fractures, in order to free up oil or gas reserves

3.5

fresh water

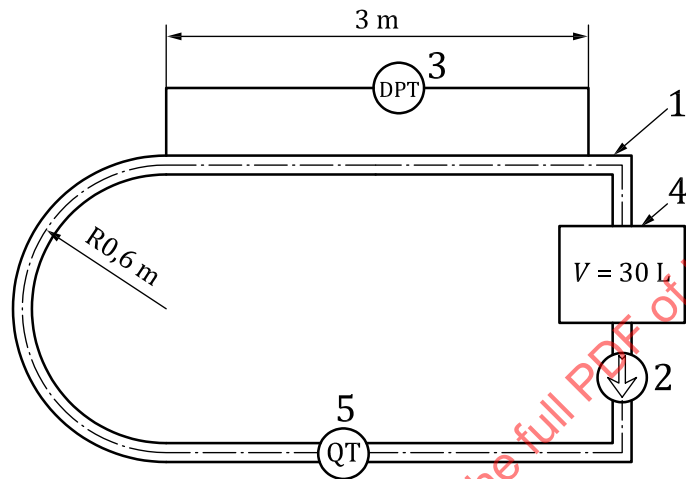
distilled water or de-ionized water with a pH of 6 to 9

4 Principle

4.1 Working principle of drag reduction test by fluid flow loop

The sketch of the measuring principle is shown in [Figure 1](#). During the test, as the fluid is circulated in the flow loop by the pump, the drag reduction of the liquid in the corresponding length of the pipe is measured by the differential pressure sensor.

The illustrated equipment is for reference only. The actual experimental equipment can be all the equipment that meets the requirements of [Clause 5](#).



- Key
- 1 test pipe
 - 2 pump
 - 3 differential pressure sensor
 - 4 mixing tank
 - 5 flow meter

Figure 1 — Working principle of the fluid flow loop

4.2 Calculation formula

The drag reduction of slick water is calculated by [Formula \(1\)](#):

$$D_R = \frac{\Delta p_1 - \Delta p_2}{\Delta p_1} \times 100 \tag{1}$$

where

- D_R is the drag reduction of slick water, %;
- Δp_1 is the pressure difference when fresh water flows through the pipe, keep the same sample, Pa;
- Δp_2 is the pressure difference when slick water flows through the pipe, keep the same sample, Pa.

NOTE The reference conditions are 25 °C, 101,325 kPa.

5 Measurement device

5.1 Fluid flow loop

5.1.1 Mixing tank

A mixing tank of no less than 30 l is used to fill the test liquid. The mixing tank should be equipped with mechanical stirring system composed of motor, stirring rod and stirring blade, the stirring speed is (500 ± 100) r/min.

5.1.2 Test pipe

The test pipe is an open circuit composed of a curved pipe and straight pipes. The average roughness of the inner steel pipe surface shall be $3,2 \mu\text{m} \pm 1 \mu\text{m}$ (average roughness R_a , see ISO 8503-4), the diameter of the curved pipe is 0,6 m, the length of the straight pipe ≥ 6 m. The pipe inner diameter is 8 mm.

5.1.3 Pump

A progressive cavity pump is used to circulate the test liquid. The range of flow rate is minimum (0 to 2) $\text{m}^3 \cdot \text{h}^{-1}$.

5.1.4 Flow meter

A mass flow meter is used to test the flow rate of the test liquid. The range of measurement is minimum (0 to 35) $\text{kg} \cdot \text{min}^{-1}$ and the relative error of the flow meter is maximum 0,20 %.

5.1.5 Pressure sensor

A differential pressure sensor or two absolute pressure sensors are used to test the differential pressure of the test liquid. The range of measure is 0 kPa to 700 kPa, and the relative error of the pressure sensor is $\pm 0,25$ % full scale.

5.2 Electronic balance

Maximum weighing is minimum 100 g, weighing accuracy at least 0,01 g. It is used to weigh the solid drag-reducing agent.

6 Reagents and materials

6.1 Water

Distilled or deionized water is used to prepare the slick water.

6.2 Additive

Prepare additives for slick water, such as drag-reducing agent, surfactant, bactericide, etc., the purity of additives is required according to the test requirements.

7 Measurement

7.1 Preparation

Prepare the slick water according to the prescribed composition including water, drag-reducing agent, surfactant, bactericide, etc.